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Research Areas

Static analysis of software, the computational complexity of such analyses, advanced type systems, and provably-secure programming languages.

Research Description

As attempts are made to automate the software development process through rapid prototyping and other means, there is an increasing need for new forms of automated analyses of specifications and code. These analyses can provide useful information about functionality and behavior that can aid in the software design process. The goal of the Advanced Type Systems Project at NPS is to develop new forms of static analyses within the well-understood context of type systems. Its current members include Geoffrey Smith at Florida International University and Professor Irvine at NPS. Consult the URL `http://www.cs.nps.navy.mil/research/languages/` for more information and copies of published papers.

Currently there are two major research thrusts in the project. One involves developing the type-theoretic foundation for sound polymorphic typing in the popular imperative programming languages C. A sound type system for a polymorphic dialect of K&R C has been developed. It is very well known that getting soundness in the context of polymorphism and pointers, or references, is difficult. The system was proved sound with respect to a natural semantics for core C. The type system of Edinburgh LCF ML was also proved sound. Although widely conjectured to be sound, its soundness actually remained an open problem for almost 20 years. This part of the project is currently being supported by the NSF.

The second major thrust of the project is the development of a secure information flow type system. Based on the work above, we have developed a type system for statically checking programs in a basic imperative programming language for illegal information flow. This is useful in the context of Web programming where perhaps a downloaded script attempts to make some sensitive information about the user, say a mail folder, publicly available by mailing it to everyone. Such unauthorized disclosures would be prevented if the script were type checked in our system prior to execution.

Relevance to DoN/DoD

New programming methodologies and support for software development is extremely important to DoN and DoD. The rising cost of developing and maintaining software for military applications has made new software development technology imperative. The Advanced Research Projects Agency has developed a research agenda with several major thrusts, two of which are rapid prototyping and megaprogramming. Critical to the success of both areas are more flexible type systems which the Advanced Type Systems Project addresses directly.

Recent Publications

Smith, G. and Volpano, D., "Polymorphic Typing of Variables and References". *ACM Trans on Programming Languages and Systems*, Vol. 18, No. 3, pp. 254-267, May 1996.

Volpano, D. and Smith, G., "On the Systematic Design of Web Languages". *ACM Computing Surveys*, Vol. 28, No. 2, pp. 315-317, June 1996.

Smith, G. and Volpano, D., "Towards an ML-style Polymorphic Type System for C", Proc. 6th European Symposium on Programming, pp. 341-355, April 1996.

Volpano, D., "Lower Bounds on Type Checking Overloading". *Information Processing Letters, 57*, No. 1, pp. 9-14, Jan 1996.

Volpano, D. and Smith, G., "A Type Soundness Proof for Variables in LCF ML". *Information Processing Letters, 56*, No. 3, pp. 141-146, Nov. 1995.

Volpano, D. , Smith, G. and Irvine, C., "A Sound Type System for Secure Flow Analysis", *Journal of Computer Security*, Vol. 4, No. 3, pp. 167-187, December 1996.